EXPERIMENTAL FACILITIES DEVELOPMENT

RADIATION-EFFECTS RESEARCH FACILITIES

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The Radiation Effects Research Program (RERP) has grown rapidly in the last year. There are now five members (NASA Goddard Space Flight Center, NASA Johnson Space Center, Sandia National Laboratories, the Jet Propulsion Laboratory, and Lockheed Martin) of the Indiana Radiation Effects Research Alliance who have prepaid $20,000 for access to proton beams for radiation-effects studies of micro- and opto-electronic components and systems that are to be used in the harsh space-radiation environment. These and several other users have made active use of the Radiation Effects Research Station (RERS) in recent months. The operation of this end station, which is shown schematically in Fig. 1, is described elsewhere[1] and remains fundamentally the same. However, interactions with users, increased activity and the availability of funds from access fees have resulted in enhanced capabilities and significant improvements in the ease of use. These improvements and some planned for the near future are described and the present proton capabilities of RERS summarized here.

A laser alignment tool was designed and built. It allows rapid and precise placement of an electronic component to be irradiated at the chosen location in the beam. In order to facilitate this process further, a precision vertical lift was purchased and an xz translator for the device support platform was built. The time for positioning and repositioning a device under test (DUT) has been significantly reduced by these changes.

The QQSP spectrometer has been removed from the beam line used for the RERS. Previously, only the QQSP scattering chamber had been removed to make space for the RERS target chamber and the QQSP itself used to support part of the end station. Removal of the QQSP required installation of beam line supports and realignment of the RERS beam line. It has made it possible to get to both sides of the RERS beam line and has greatly improved ease and efficiency of operation.

A technique using a small plastic scintillator directly in the beam has been implemented and successfully used to perform irradiations with fluxes as low as 500 protons/s/cm^2 at several energies. Lower energies were obtained by degrading the beam energy from 200 MeV by inserting copper plates in the beam just ahead of the DUT. The energy distributions of these low-flux direct beams were measured at the degraded energies with a 1-inch thick plastic dE/dx detector followed by a 5-inch thick sodium-iodide detector.

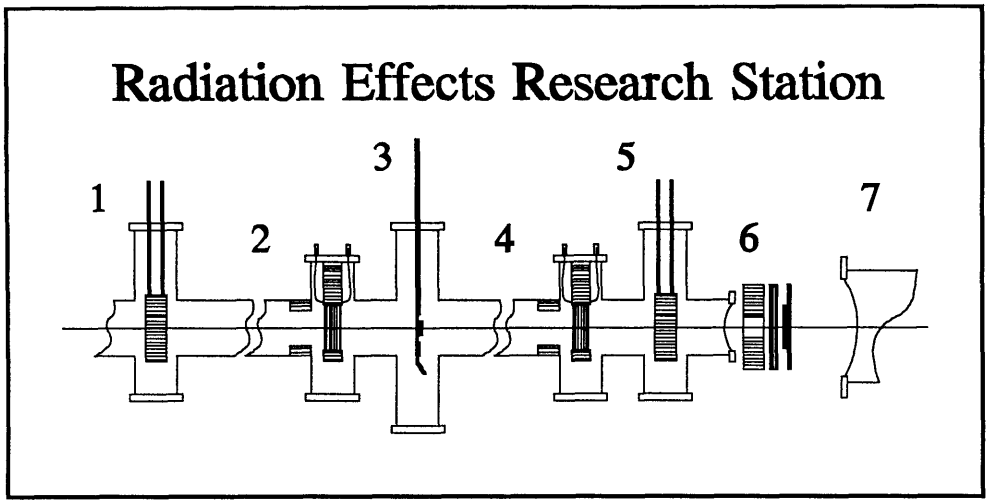

Figure 1. Schematic view of the RERS. The proton beam goes from left to right. Shown are the movable upstream beam stop (1), upstream secondary-electron monitor (2), beam-spreader target ladder (3), dosimetry secondary-electron monitor (4), movable dosimetry beam stop (5), air gap with external collimator, energy degrader and device under test (6), and entrance to a well-shielded Faraday cup beam dump (7). Drawing is not to scale. The distance from (3) to (6) is about 10 feet and the beam pipe is 4 inches in diameter.

A study of the effect of degrading the beam energy on the dose at the position of the DUT was completed by the REU student Amy Johnson. Lockheed Martin has loaned IUCF a linear translator that has been used to position degrader plates remotely. This saves approximately 3 min per energy change because it eliminates the need for an entry into the interlocked radiation vault. The linear translator has four positions that are 3 inches apart. One position is kept empty for maximum energy beam. The other three positions may be loaded with different thicknesses of degraders. Four standard degrader loads, and three standard device positions were established. By exposing GAFCHROMIC^{TM} film at each position and with each degrader thickness, the ratios of the fluences at each position to the fluence just upstream of the degraders was determined for each energy . The flux just upstream of the degraders is measured in real time through the use of a calibrated secondary-electron emission monitor. This scheme is used by the control computer to determine exposure durations for preset fluences or preset doses. This calibration effort has resulted in a very flexible and efficient capability to irradiate up to three devices simultaneously (one at each of the standard positions) and to expose devices at 11 energies from 25 MeV to 196 MeV. Table 1 summarizes the current capabilities of the RERS.

As part of current remodeling efforts, it is planned to build an enclosed counting/dosimetry room just outside the entrance to the vault containing the RERS. This will provide a low dust, low noise, controlled space for users of the facility. Construction of this counting room is expected to be completed by early 1997. A preliminary design for a Large Area Radiation Effects Research Station (LARERS) has been completed. This will allow irradiation of an entire device up to 18 inches in diameter (such as a laptop com-

Table I. Proton Capabilities of the RERS (1996)	
Energy Range:	25 to 200 MeV (11 precalibrated energies at 3 positions by degrading)
Flux:	10^6 to $> 10^{11}$ protons/s/cm^2 (Using a secondary electron monitor) 10^2 to 10^5 protons/s/cm^2 (Using small plastic scintillator monitor)
Areas:	< 2 cm to 7 cm diameter
Uniformity:	$< 30\%$ variation over area
Absolute Dosimetry:	Better than 10% routinely
Exposure Durations:	> 5 seconds routinely available
Overhead duration: For energy changes and device positioning	3 minutes per exposure Due to delayed room entry and room-clear requirement of radiation safety system. (Remotely operable energy degrader insertion system reduces room entries for energy changes by factor of 3.)
Device Mounting and Alignment	Convenient and flexible mounting of components, circuit boards and entire systems using manual xz positioner and laser-alignment tool.

puter) in a single exposure. Funds are being sought for the development and construction of this station.

1. C. Foster, T. Rinckel, and K. Murray, Jr., IUCF Sci. and Tech. Rep. May 1994 - April 1995, p. 179.